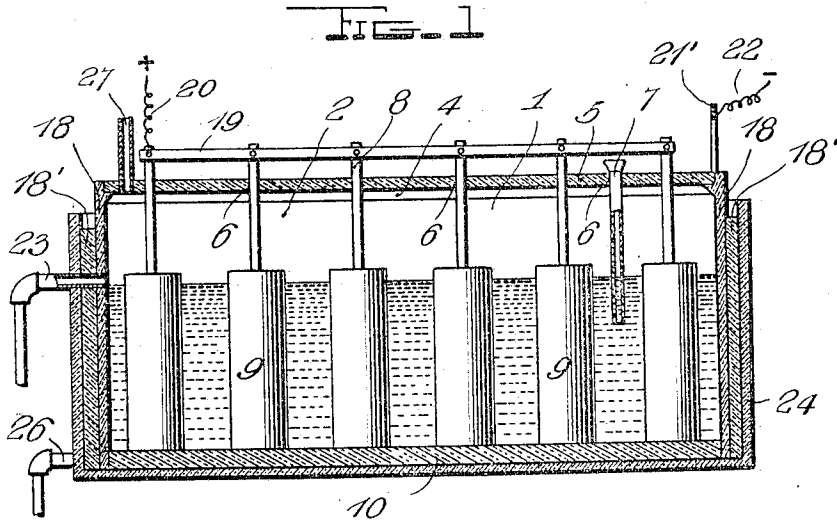
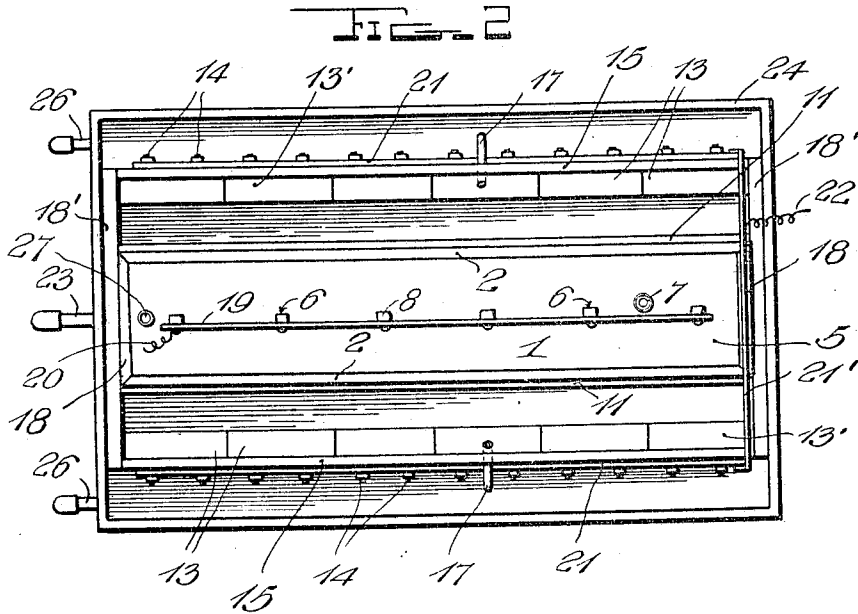


F. McDONALD.
ELECTROLYTIC CELL.
APPLICATION FILED APR. 20, 1914.

Patented Nov. 17, 1914.

2 SHEETS-SHEET 1.

1,117,879.



Inventor

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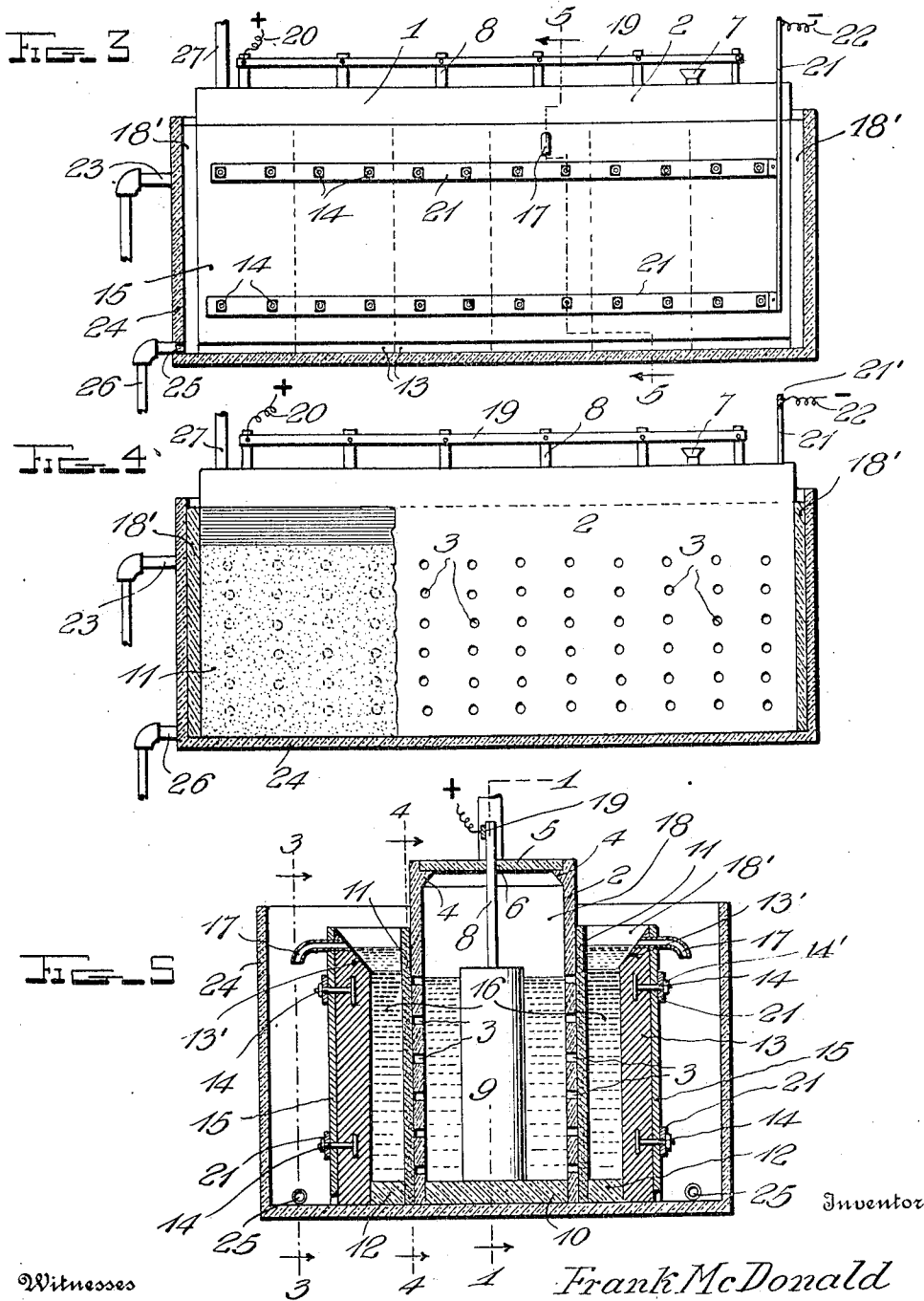
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UNITED STATES PATENT OFFICE.

FRANK McDONALD, OF ROARING SPRING, PENNSYLVANIA.

ELECTROLYTIC CELL.

1,117,879.

Specification of Letters Patent.

Patented Nov. 17, 1914.

Application filed April 20, 1914. Serial No. 833,262.

To all whom it may concern:

Be it known that I, FRANK McDONALD, a citizen of the United States, residing at Roaring Spring, in the county of Blair and State of Pennsylvania, have invented certain new and useful Improvements in Electrolytic Cells; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to electrolytical cells for the electrolysis of the metallic salts, but especially solutions of the alkaline chlorids

One object of my invention is to provide a cell of this character in which intermingling of the anode and cathode products is prevented, all secondary reactions which might result by reason thereof eliminated, and a high current efficiency, constantly maintained.

Another object is to provide a means for amalgamating the alkaline metals obtained by the electrolytical process, decomposing the amalgam thus formed and recombining the alkaline metals obtained by the decomposition to form hydrates.

Another and further object is to provide a means which while serving as a support for the mercury column will nevertheless permit the electrolyte to contact therewith.

Another and still further object is to provide a cell wherein the electrolyte may be decomposed and the ionic products carried off and maintained separately, without necessitating the use of any mechanical means such as a pump, etc.

With these and other objects in view, my invention consists of certain novel details of construction and combination and arrangement of parts which will be more particularly pointed out and claimed.

In the accompanying drawing in which similar parts are designated by corresponding reference numerals:—Figure 1 is a longitudinal section taken on the line 1—1 of Fig. 5. Fig. 2 is a top plan view thereof. Fig. 3 is a longitudinal section taken on the line 3—3 of Fig. 5. Fig. 4 is a similar view taken on the line 4—4, part of the perforated partition being broken away to illustrate the contiguously disposed porous plate. Fig. 5 is a transverse vertical section on an enlarged scale taken on the line 5—5 of Fig. 3.

In the present exemplification my invention comprises an anode chamber 1, consisting of the two vertically disposed and suitably spaced partitions 2, formed of a non-conducting and acid resisting material such as stoneware or slate, etc., and provided with apertures 3, which latter terminate a short distance from the upper extremities of said partitions, in other words, they terminate at what is the normal level of the electrolyte. On the inner extremities of the partitions 2 adjacent their upper ends are shoulders 4 which receive and support the acid proof slate cover 5. This cover is formed with a plurality of centrally arranged and alined opening 6, one of which is adapted to receive the stem of a glass or rubber funnel 7, whereby the brine or other electrolyte can be conveniently poured into said anode chamber or compartment, while the remaining openings receive the leading in rods 8, attached to the upper ends of graphite anodes 9, which are disposed upon the slate flooring 10, in spaced relation to each other and to the partitions 2. To prevent any escape of the chlorine gas collected in the anode compartment above the liquid therein, I hermetically seal all openings around the cover as well as the leading in rods 8 and funnel 7, with a coating of cement consisting of barium sulphate and linseed oil worked to a thin paste.

Contiguous to the exterior of partitions 2 are disposed the porous diaphragms 11 preferably composed of clay or asbestos cloth impregnated with an emulsion formed of barium sulphate and water. In either case the portion of this diaphragm which is to project above the normal level of the electrolyte is rendered water-proof by an application of pitch applied while hot.

These diaphragms 11 while possessing the necessary strength and durability to support the vertical column of mercury to be hereinafter referred to, nevertheless by reason of their porosity allow the liquid in the anode compartment to percolate through and contact with the said mercury.

Suitably spaced from the diaphragms 11 by the gasket 12, the width of which depends on the width of the column of mercury desired, are two vertically disposed graphite walls 13, formed in sections and having a height corresponding to that

of the aforementioned diaphragm as clearly shown in Fig. 5. Secured to the exterior of walls 13 by bolts 14 formed in the graphite, are sheet iron plates 15 which bind the various blocks of graphite 13, so as to form a unitary wall structure.

The space between a wall 13 and the porous diaphragms 11 is filled with mercury 16 forming a column thereof whose upper end extends slightly above the uppermost apertures in the plates 2.

To form a decomposing chamber above the mercury column, to decompose the amalgam formed in a manner to be hereinafter related, the inner faces of the upper portions of graphite walls 13 are beveled as at 13' and the space between the same and the water-proof section of diaphragm 11 is filled with water, which latter is maintained at a constant level therein by means of the overflow pipes 17 passing through the upper end of said walls 13.

The open ends of the anode compartment 1, formed by the two partitions 2 are closed by the acid proof end pieces 18, suitably secured thereto. The remaining open ends of the mercury containing or cathode compartment are closed by plates 18' which extend across the entire cell and are riveted to the opposite ends of graphite walls 13.

In order that the anodes and cathodes of my cell may be properly placed in circuit, the free ends of leading in rods 8 carried by anodes 9 are secured to a bus bar 19 which is connected with the positive conductor 20 leading from a suitable source of current supply; while the cathodes are in circuit through the bus bars 21, connected to the negative conductor 22 extending from the same source of supply, said bars being disposed upon the free ends of bolts 14 and retained thereon by nuts 14'. As it is necessary to have all of the last mentioned bus bars 21 in circuit with negative conductor 22, I provide the connecting rods 21' overlying one of the plates 18' and secured at their extremities to said bus bars 21 as clearly shown in Fig. 2.

For the maintenance of a constant electrolyte level in the anode compartment I provide an overflow pipe 23 extending through one end thereof as shown in Figs. 1 and 2.

After my improved cell has been assembled in the manner set forth, it is placed within an iron overflow tank 24 the same having therein the outlet openings 25, communicating with leads 26 by means of which the overflow caustic soda from the cell can be readily withdrawn from said tank.

Having now fully set forth the structural details of my invention, the *modus operandi* of the same is as follows: Chamber 1 is filled with brine until the highest level of the same is attained; next, the spaces inter-

mediate graphite walls 13 and porous diaphragms 11 are filled with mercury which extends slightly above the level of the electrolyte in the anode chamber. The mercury when thus arranged forms an absolute seal preventing any diffusion of the brine solution with that of the caustic soda in the cathode chamber. Water is now placed above the mercury between the beveled faces of graphite walls 13 and the water-proof extremities of diaphragm 11, its level being maintained constant by the overflow pipes 17. When the cell thus equipped is placed in an electric circuit, the current will flow from the positive wire 20 to bus bar 19 from the latter to graphite electrodes 9, through the electrolyte or brine, thence to the mercury, graphite walls 13, through plate 15 and bus bars 21 and 21' to the negative conductor 22. This current, owing to the fact that the chlorine is an electro-negative element causes an evolution of the latter at the anodes 9, where it is collected in the chamber formed above the electrolyte and from whence it is conveyed through the pipe 27 to any desired point. The sodium element being electro-positive is deposited at the negative pole or cathode which as will be readily apparent is the side of the mercury column adjacent the anode compartment, where it immediately unites with the mercury to form mercury amalgam. Now, however, as the specific gravity of the mercury amalgam formed is less than that of the mercury the former will rise to the top of the column of mercury where, in the presence of the water and being in contact with the graphite wall it will be decomposed into its original constituents of mercury and sodium. The sodium thus liberated reacts with the water to form caustic soda and free hydrogen gas.

Of course it will be understood that in practice as many of the alternate compartments of anodes and cathodes as may be desired can be built up together but I prefer to use the center compartment for the anodes, and the vertical column of mercury, porous diaphragm, graphite walls and sheet iron plates for the cathodes as herein shown and described.

Various changes in the form, proportion and the minor details of construction may be resorted to without departing from the principle or sacrificing any of the advantages of the claimed invention.

I claim as my invention:

1. An electrolytical cell comprising an anode, a porous wall spaced therefrom, a graphite cathode member offset from the latter, a column of mercury disposed between said cathode member and said porous wall, and a decomposing element disposed above and supported by said mercury, substantially as and for the purpose set forth.

2. An electrolytical cell comprising an anode, a reticulated wall spaced therefrom, a cathode member offset from the latter, a column of mercury disposed between said cathode member and reticulated wall, and a porous diaphragm intermediate the wall and said mercury column to support the latter.

3. An electrolytical cell of the character described comprising an anode a perforated partition spaced therefrom, a porous diaphragm disposed contiguous to the latter, a cathode member adjacent to and spaced from said diaphragm and a column of mercury interposed between and supported by said diaphragm and cathode member, and a decomposing element above said mercury column and between the upper extremities of said cathode member and diaphragm.

4. In an electrolytical cell of the character described the combination of an anode, a reticulated partition spaced therefrom, a contiguously disposed porous diaphragm, a graphite cathode member having the inner face of its upper extremity beveled, a column of mercury disposed between and supported by said diaphragm and cathode member and a decomposing element interposed above said mercury column and intermediate the beveled face of said cathode member and the upper extremity of said porous diaphragm.

5. In an electrolytical cell of the character described the combination of an anode, a reticulated partition spaced therefrom, a contiguously disposed porous diaphragm, a graphite cathode member adjacent to and spaced from said diaphragm, said cathode member having the inner face of its upper extremity beveled, a column of mercury disposed between and supported by said diaphragm and cathode member and a decomposing element interposed above said mercury column and intermediate the beveled face of said cathode member and the upper extremity of said porous diaphragm, and means for maintaining said decomposing element at a constant level.

6. An electrolytical cell of the character described comprising an anode, a reticulated partition spaced therefrom, a contiguously disposed porous diaphragm, a graphite cathode offset therefrom, means intermediate said cathode member and said diaphragm to amalgamate the products deposited at the cathode, and means disposed above the last mentioned means for decomposing said amalgam, substantially as and for the purpose set forth.

7. An electrolytical cell of the character described comprising a series of spaced anodes, having connecting rods vertically disposed at the upper end thereof, reticulated partitions arranged on opposite sides and in spaced relation to said anodes, a cover

carried by said partitions, the latter having therein openings to receive said rods, graphite cathode members adjacent to and offset from each of said partitions, mercury interposed between the latter and said cathode members, and a porous diaphragm intermediate said mercury and said partition to support the former.

8. An electrolytic cell of the character described comprising a series of anodes provided with vertically extending connecting rods, reticulated partitions offset from and disposed on opposite sides of said anodes to form an electrolyte compartment, said partitions having the apertures therein terminating at the normal level of said electrolyte, a perforated cover disposed upon said partitions and coacting with the non-perforated sides of the latter to form a gas chamber the vertically extending rods on said anodes projecting through the perforations in said cover, graphite walls arranged in spaced relation to said partitions, mercury interposed between the latter and said graphite walls, porous diaphragms intermediate the partitions and the mercury to support the latter, and end pieces secured to the extremities of said walls to form a closure for the open ends of the cell.

9. An electrolytic cell of the character described comprising a series of anodes provided with vertically extending connecting rods, reticulated partitions offset from and disposed on opposite sides of said anodes forming an electrolyte compartment, said partitions having the apertures therein terminating at the normal level of said electrolyte, a perforated cover disposed upon said partitions and coacting with the non-perforated sides of the latter to form a gas chamber the vertically extending rods on said anodes projecting through the perforations in said cover, graphite walls arranged in spaced relation to said partitions, mercury interposed between said walls and said partitions, metal plates secured to the exterior of said graphite walls, porous diaphragms intermediate the partitions and the mercury to support the latter, and end pieces secured to the extremities of said walls to form a closure for the open ends of the cell.

10. An electrolytic cell of the character described comprising a series of anodes provided with vertically extending connecting rods, bus bars connecting said rods, reticulated partitions offset from and disposed on opposite sides of said anodes forming an electrolyte compartment, said partitions having the apertures therein terminating at the normal level of said electrolyte, a perforated cover disposed upon said partitions and coacting with the non-perforated sides of the latter to form a gas chamber the vertically extending rods on said anodes pro-

jecting through the perforations in said cover, graphite walls arranged in spaced relation to said partitions, metal plates secured to the exterior of said plates, bus bars
5 connected with said plates, mercury interposed between said walls and said partitions, a porous diaphragm intermediate the partitions and the mercury to support the latter, and end pieces secured to the extremities of said walls to form a closure for the
10 open ends of the cell.

11. An electrolytic cell of the character described comprising a series of anodes, reticulated vertical partitions disposed adjacent thereto and offset therefrom to form
15 an anode compartment adapted to receive an electrolyte, said partitions having the openings therein terminating at the normal level of said electrolyte, a cover disposed upon said partitions coacting with the non-perforated portion thereof to form a gas
20 chamber, graphite walls arranged in spaced relation to said partitions, mercury interposed between said graphite walls and said
25 partitions, a porous diaphragm intermediate the latter and said mercury to support the same, and a decomposing element dis-

posed above said mercury substantially as and for the purpose set forth.

12. An electrolytic cell of the character
30 described comprising a series of anodes, reticulated vertical partitions disposed adjacent thereto and offset therefrom to form an anode compartment adapted to receive an electrolyte, said partitions having the open-
35 ings therein terminating at the normal level of said electrolyte, a cover disposed upon said partitions and coacting with the non-perforated portion thereof to form a gas
40 chamber, graphite walls arranged in spaced relation to said partitions, mercury interposed between said graphite walls and said partitions, porous diaphragms intermediate the latter and said mercury to support the same, a decomposing element disposed above
45 said mercury and means to maintain said decomposing member at a constant level.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

FRANK McDONALD.

Witnesses:

J. P. MARTIN,
R. D. LORENZ.